NOV 10 1925

East Engin.
Library

Volume 11 October, 1925 *Number 10*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Electric Motors and Their Lubrication

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

The Outstanding Factor in Electric Motor Operation

A STUDY has been made, in this issue, of the electric motor, especially from the viewpoint of that outstanding factor—lubrication.

To enlighten the layman, the function, design and construction of the motor have been taken up. Too, we present an exhaustive discussion of the several electric motor bearing lubricating systems in common use today, with an analysis of the various characteristics of the respective lubricants required.

The electric motor is perhaps the most general all-round machine applicable to the mechanical requirements of civilization and the reduction of laborious effort. It is, therefore, worthy of our most careful attention. Yet, too many of us are prone to regard the motors in our shops, electric trucks, vacuum cleaners or what not, as veritable beasts of burden.

To be true, there are but two wearing elements involved, and motor builders, realizing the natural deficiencies of mankind, have designed these for as automatic lubrication as is practicable. Therefore, as long as clean, pure lubricants are used, effective lubrication is generally assured.

But lubricants cannot withstand contamination by dust, dirt, etc., nor the off-times vaporizing effects of higher temperatures, however carefully they may have been refined or compounded. The operator must realize these facts, and the necessity for periodic cleaning of such lubricating systems and renewal of lubricants. He is dealing with one of the most delicate mechanisms of industry, and abuse or neglect of its lubricating requirements will most surely cause trouble.

We, therefore, commend this article to your attention, whether you be a steel mill executive, a textile operator, the owner of a motor car, or Mrs. Housewife who desires the best results from her vacuum cleaner or ice-less refrigerator.

There is a Texaco lubricant for whatever type of motor bearing or operating condition you may have. The chart shown on the inside back cover is indicative of this, and we recommend it to your careful study.

THE TEXAS COMPANY, U. S. A.

Texaco Petroleum Products

Dept. H, 17 Battery Pl., New York City

Atlanta	Dallas	Houston	New Orleans	Oklahoma City
Boston	Denver	Jacksonville	New York	Philadelphia
Chicago	El Paso	Minneapolis	Norfolk	Spokane

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published Monthly by

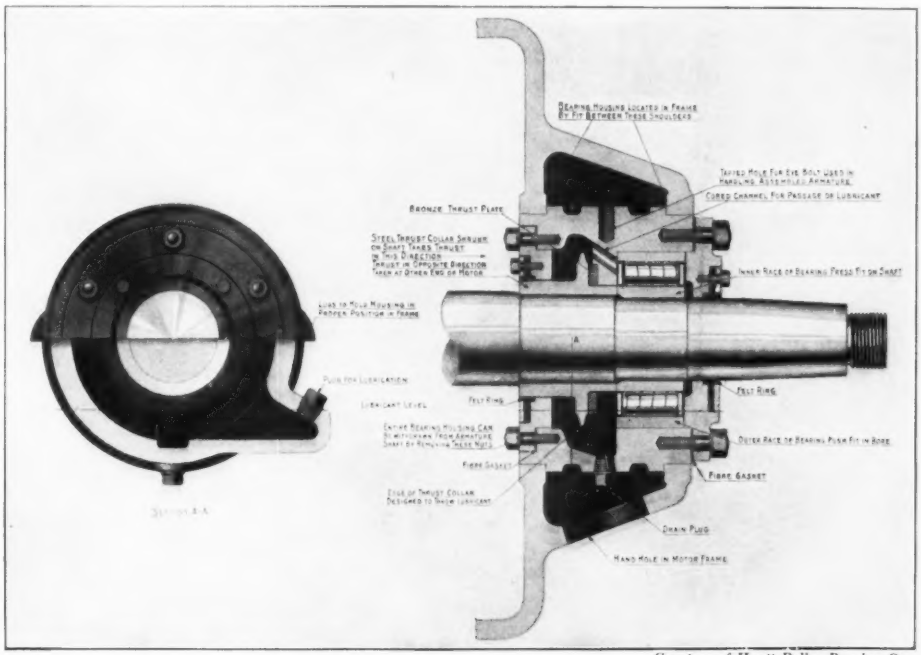
The Texas Company, 17 Battery Place, New York City

Copyright 1925, by The Texas Company

Vol. XI — October, 1925 — No. 10

Change of Address: In reporting change of address kindly give both old and new addresses.

"While the contents of LUBRICATION are copyrighted, other publications will be granted permission to reprint on request, provided article is quoted exactly and credit given to THE TEXAS COMPANY."


Bearing Housing Located in Frame by Fit Between These Shoulders
Tapped Hole for Eye Bolt Used in Handling Assembled Armature
Bronze Thrust Plate
Steel Thrust Collar Secured on Shaft Takes Thrust in This Direction
Thrust in Opposite Direction Taken at Other End of Motor
Inner Race of Bearing Press Fit on Shaft
Felt Ring
Outer Race of Bearing Push Fit in Bore
Fibre Gasket
Drain Plug
Hand Hole in Motor Frame

Courtesy of Hyatt Roller Bearing Co.

Fig. 1—Details of a mill motor equipped with flexible roller bearings.

Electric Motors and Their Lubrication

THE application of electric power to the propulsion of industrial machinery has brought about marked developments in electric motor design and construction. In effect the motor is as nearly the keystone machine of industry as any piece of operating equipment. Upon its efficiency, its ability to operate for extensive and continuous periods, and its durability in the face of detrimental conditions, depends the productive efficiency of practically every machine or process to which it is coupled.

In turn the efficiency of the motor itself largely depends upon the efficiency with which

its bearings are lubricated. The fact that these are the principal wearing elements involved, too frequently gives rise to the opinion that they require more than the average amount of attention. The necessity for their lubrication is appreciated by most operators, but oftentimes it is felt that this only involves the addition of "some oil" now and then. Many are prone to overlook questions such as: what this oil should be, the constructional details of the bearings, and the lubricating requirements imposed by virtue of the operating conditions. Perhaps this is a pardonable attitude, for the builders of electric motors have given every care to the design of their bearings with a view to rendering lubrication as positive and automatic as possible.

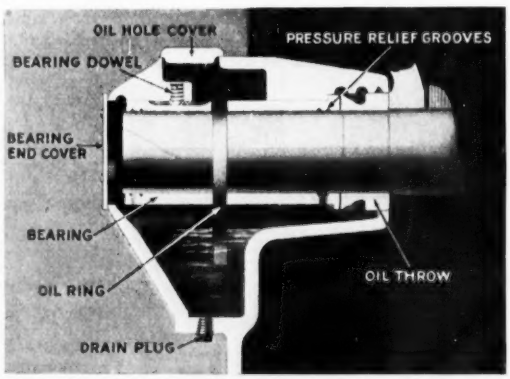
The logical result is that the average operator under normal conditions of operation will experience little or no difficulty from a lubricating point of view. On the other hand, an installation subjected to abnormal temperatures, as for example in an economizer housing, adjacent to a kiln, etc., or exposed to dust and dirt as in a flour or cement mill may easily prove the exception to the rule. Such conditions require an intimate knowledge of the construction of the bearings involved and the extent to which oils or greases of varying characteristics can be applied in accordance with operating requirements. As a result it is absolutely essential that all concerned with electric motor operation, maintenance and repair be conversant with the design and limitations of bearing lubricating systems.

FUNCTION

The essential function of the electric motor as a converter of electrical into mechanical energy is to transmit the power developed by electric generators to producing or materials handling machinery such as line shafting, pumps, machine tools, textile equipment, laundry apparatus, etc. In fact it can be broadly regarded as probably the most generally applied prime mover in modern industry. From the fractional horse-power motor which serves to relieve the drudgery in our homes by operating washing and ironing machines, oil burners, and vacuum cleaners, to the huge reversing equipment required in the modern steel rolling mill, the electric motor is a factor in improving the efficiency of industrial production and reducing the cost and labor of living.

In connection with the application of the electric motor, however, it is well to note its electrical features and to look, for a moment, into the several types of motors available and their adaptability to certain phases of operation. Essentially motors are broadly classified as functioning on direct or alternating current. That is, according to whether the power is constant in its magnitude, polarity and direction of flow, or whether it alternates repeatedly in polarity varying successively from a maximum in one direction to a maximum in the other.

According to the design and service required direct and alternating current motors are in turn known severally as series, shunt or compound wound, as single phase, polyphase, synchronous or as induction, etc. To the electrical engineer these terms are self-explanatory. Further discussion is unnecessary, for the



Courtesy of Reliance Electric & Engineering Co.

Fig. 2—Cross-sectional view showing a ring-oiled bearing construction. Note precautions to keep oil from inside of motor.

electrical engineer and motor expert should always be consulted prior to selecting any particular kind of motor for any service. Each has its distinctive advantages for certain types of work. For example, the direct current motor in general is subject to better speed control; this is a factor in the operation of materials handling equipment such as cranes, power shovels, etc. Truck, tractor, hoist and elevator motors, in turn, which must often be started from rest under considerable loads require a high starting torque. Alternating current is advantageous due to the ease, economy and simplicity with which power can be transmitted over relatively long distances.

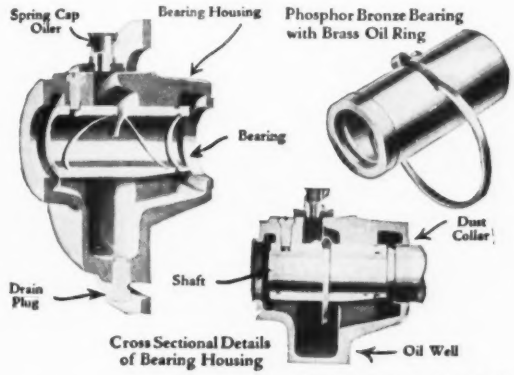
From a lubricating point of view, however, electric motors regardless of their type or winding present essentially the same requirements according to the construction of their bearing lubricating systems.

CONSTRUCTION

From a constructional point of view an electric motor consists essentially of a frame or stationary element known as a stator, and a revolving armature called the rotor. The former contains a number of field poles suitably wound with wire, the latter is fitted with a

series of coils of wire. Delivery of electric current to one or both windings brings about rotation of the armature in accordance with the law that a magnetic pole will attract or repel an electric conductor, such as an armature coil, in which an electric current is flowing, according to the polarity.

The rotor, of course, involves a central shaft or journal, which in turn must be carried in suitable bearings located in the stator or frame. These are the only wearing parts of the electric motor wherein lubrication is necessary.



Courtesy of Century Electric Co.

Fig. 3—Details of a modern ring-oiled bearing showing oil grooving, ring and bearing relation, dust collar, etc.

It can be appreciated that the most perfect lubrication is an absolute necessity for efficient motor operation. Any development of abnormal wear of the bearings might very easily cause pounding of the shaft with the possibility of the armature coils coming in contact with the pole pieces of the stator, resulting in burnouts. But prior to these extremes, faulty lubrication would be the cause of continued losses in efficiency due to the natural increase in friction which would most surely result. This would be indicated by increases in bearing temperatures, even if the power capacity of the motor was not marked in its reduction. As a rule this latter is a serious matter in any plant where motors must be capable of operation at their rated capacity. Any inability to do this work might easily affect production or plant operation to a marked degree.

LUBRICATING SYSTEMS

In view of the above, electric motor builders have given every care to the perfection of their lubricating systems.

Ring Oilers

Perhaps the most generally known of these latter is the ring oiler whereby oil is continually carried to the bearing surfaces from a reservoir which is part of the bearing housing, by means of a ring which is suspended from the shaft, dipping into the oil to a more or less extent according to the level at which the oil is carried. In order to insure effective lubrication by a ring oiler it is important that the reservoir be of adequate capacity to give the oil ample opportunity to rest, thereby making possible not only the settling out of sediment and other foreign matter, but also cooling to the requisite degree. As a rule the only way in which the oil in such a system is kept at the proper temperature is by radiation of heat from the exterior surfaces of the reservoir or well.

In event of this latter being of apparently insufficient capacity it is possible to overcome this by fitting an auxiliary reservoir below the one in question. One way in which this can be done is to tap a short length of pipe into the lower part of the bearings, plugging the bottom end with a cap. Such a device has an added advantage in that it also acts as a dirt collector.

Another important factor which requires consideration is the matter of oil finding its way into the motor. This may be due either to windage in company with the development of oil spray where the oil level is carried too high, or to the fact that the oil overflow is not large enough.

It is apparent that oil which is carried to the top of a ring-oiled bearing must be taken care of and returned to the reservoir as rapidly as it is delivered by the ring. If this is not possible, oil will tend to accumulate in the upper part of the housing to ultimately be forced into the interior of the motor. This, of course, is detrimental to the coils. In fact, authorities contend

Courtesy of Century Electric Co.

Fig. 4—Exterior of oil well and bearing housing of a ring-oiled bearing, showing brass end dust cap and oil ring slot cover in place.

that in the steel industry, for example, oil-soaked insulation is one of the most prevalent motor troubles, the cost of repairs being proportionately high.

The same condition may arise if the oil is carried too high in the well, or if the ring rotates at too high a speed. This will cause a splashing and churning of the oil, with the result that wherever there is any windage or draft through the bearing and motor, the oil spray may be carried in.

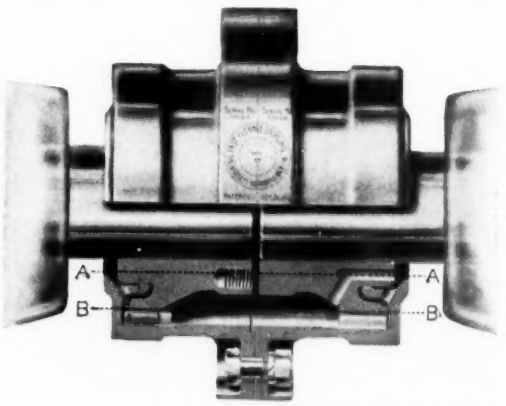
To preclude the possibility of such occurrences and as well, to protect the armature coils and pole windings, motor builders install oil baffles, throwers or labyrinth packing on the motor or inboard side of the bearing. Such devices in particular prevent direct circulation of air from the outside and through the bearing. In company with proper grooving of the bearing metal to permit ready distribution and return of the oil, they are regarded as adequate assurance that the latter will function as intended and not find its way within the motor.

To best effect lubrication by means of ring oilers, under normal temperature conditions it is essential to use a high grade straight mineral oil of approximately 150 to 200 sec. Saybolt at 100°F. In determining upon the viscosity of such an oil, especially for fractional horsepower motors, the bearing construction should be investigated; oftentimes if oil returns are too small they may become clogged, causing heavier oils to overflow and be drawn along the shaft of the armature and from there thrown onto the stator winding. By virtue of the fact that electric motors may frequently be called upon to function under abnormally low temperatures, an oil with a low cold test should be chosen wherever possible. If this latter approximates zero degrees Fahr., the oil will generally function satisfactorily. On the other hand, higher temperatures will oftentimes require additional viscosity to resist the thinning down action of heat. Under such conditions, an oil of from 300 to 400 seconds viscosity or even higher may be advisable.

Ball and Roller Bearings

So-called anti-friction bearings of the ball and roller type have been extensively adopted by electric motor builders where certain requirements such as space occupied, reduction in the amount of attention from a lubricating point of view and positiveness of action must be observed. Ball bearings can be lubricated either with oil or light grease according to the design of the bearing housings. Roller bearings can be similarly lubricated though the type and construction of the rollers must be considered in addition. Whatever their type or lubricating requirements, ball and roller bearings occupy a minimum of space, and require re-lubrication, inspection and cleaning at very infrequent intervals. The customary housing design affords ideal protection against the entry of contaminating foreign matter, and the least amount of oil or grease is required for refilling.

From a constructional point of view anti-friction bearings involve rolling contact as compared with plain bearings wherein sliding contact occurs. In ball bearings, this rolling contact is that of a theoretical point over a



Courtesy of The Bartlett Hayward Co.

Fig. 5—Efficient motor operation is frequently dependent on the efficiency of its coupling. Details of the Fast's lubricated flexible coupling are therefore of interest: B-B, is the running oil level; A-A, the standing oil level.

given surface. Roller bearings, however, involve theoretical line contact between the journal or shaft element and the outer raceway.

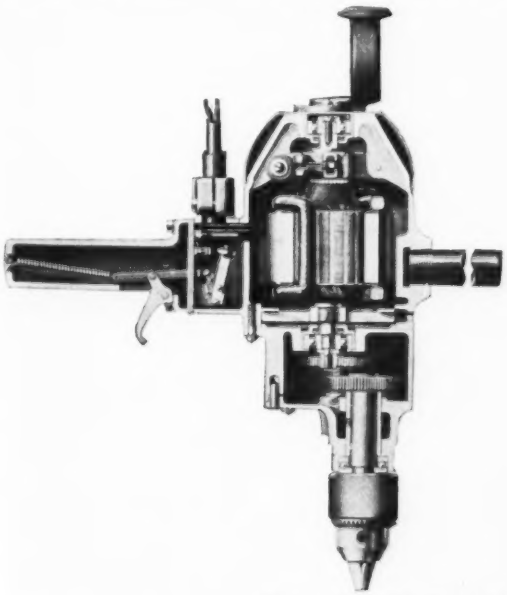
As is implied by their names such devices comprise a set of perfectly spherical balls or an arrangement of solid or flexible rollers. In general the latter will be cylindrical in shape, the distance between the inner and outer raceways being uniform throughout the length of the roller. Solid rollers on the other hand may be either cylindrical or tapered according to the type and design in question.

Whatever the nature of the rolling elements, however, such devices in general must be carried or housed in much the same manner, in suitable containers comprising raceways and cages. The inner race fits on the shaft, the outer being held by the motor frame. Between them are located the balls or rollers. These are kept in their proper positions with respect to the races, and to each other, by the separator, cage, or retainer. Rotation of the shaft sets up a rotary motion between the rolling elements and the respective inner and outer surfaces of the raceways.

In consequence the purpose of lubrication is to facilitate as easy rolling as possible. To enable this, however, all the surfaces (which are of a highly polished nature) must be in as

perfect condition as practicable. The lubricant must therefore serve the dual purpose of both lubricating, and protecting these surfaces against rusting, corrosion, pitting or abnormal wear. Minimum clearance of course is an aid to proper functioning of such bearings, for the occurrence of any play between the component parts would tend to set up a certain amount of pounding which would be detrimental to effective operation. In other words, all motion must be as nearly akin to perfect rolling as possible.

As a general rule as light a lubricant should be used as can be successfully retained in such a bearing commensurate, of course, with the temperatures and pressures involved. Usually an oil with a viscosity of from 100 to 200 seconds Saybolt at 100 degrees Fahr., will be best. Ball bearings are claimed to involve less friction to a certain extent due to the fact that there is little or no end thrust involved. As a result the lubricant in such bearings serves more nearly the purpose of acting as a metal-protecting medium. In view of this fact, and to reduce the possibility of the development of abnormal internal friction within the lubricant, it is generally advisable to pay careful attention to the oil level. Certain authorities contend that submergence of approximately one-half to three-quarters of the



Courtesy of The Fafnir Bearing Co.

Fig. 6—Phantom view of a Van Dorn Electric Tool Co. Drill, equipped with ball bearings. Note motor details, and the compactness of the entire installation.

lowest ball will be sufficient. In this connection it is important to remember that contrary to the principles of plain bearing lubrication, the oil in a ball or roller bearing plays no part as a coolant. Therefore volume is a detriment rather than an advantage.

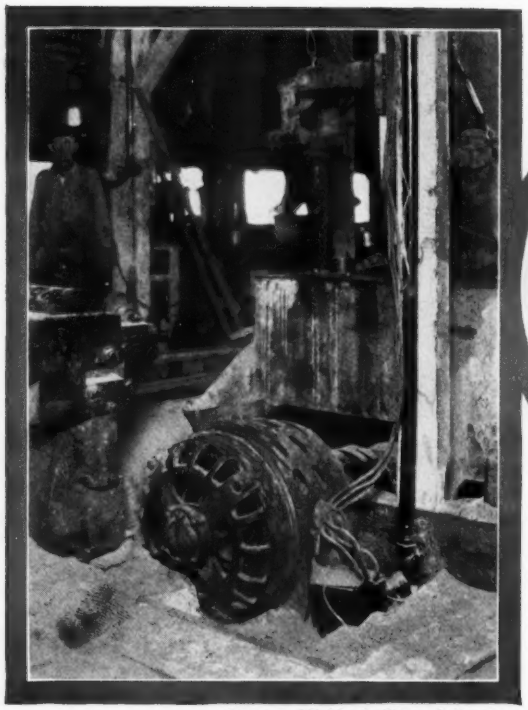
Roller bearing lubrication by means of oil is subject to much the same conditions as stated in connection with ball bearings. Where end thrust may develop to an appreciable extent, however, due to difficulty in keeping the rollers in alignment, or where pressures or temperatures may be high it is the opinion of certain authorities that it will be conducive to better lubrication if somewhat heavier oils are used. Under such conditions the use of straight mineral lubricating oils of as high as 750 seconds Saybolt viscosity at 100 degrees Fahr. are advocated. Even mineral cylinder oils of a high degree of purity may be necessary under conditions of extremely high duty, pressure or temperature. The selection of heavier oils for roller bearing lubrication, however, should be carried out with the utmost care for it is very possible to over-estimate the conditions of operation with the result that an excess of internal friction may be developed. As a rule careful observation of bearing temperatures and cooperation with the builders and oil industry will insure satisfactory results.

Wherever there is possibility of oil leakage, however, or under conditions of dust, dirt or dampness it may be advisable to resort to grease as the lubricant. Greases furnish better seals against the entry of dust, dirt and moisture thereby serving to protect the polished surfaces of the bearing elements in a very satisfactory manner. Grease also can be very much more effectively retained in a non-oil-tight housing; on the other hand, dirt or grit that finds its way into a grease lubricated bearing, has no means of settling out, but is always held in suspension, being carried back into the bearing repeatedly.

As a general rule soap-thickened oils which are comparatively fluid in consistency will meet average operating conditions where the lubricant must readily cover the entire surfaces of the balls or rollers and not tend to channel in the housings or raceways, as might occur with more viscous products of this nature which would have less of a penetrative ability. On the other hand under conditions of high temperature as for example in the case of certain steel or cement mill motors, it might be necessary to resort to greases of greater body to withstand the thinning-out effects of heat, and prevent the consequent entry of dust or dirt.

Relative to the amount of grease to be used in a ball or roller bearing it is interesting to note that in the case of ball bearings the S.K.F. Industries, Inc., recommend that the housing be from ¼ to ½ full. They further state that—

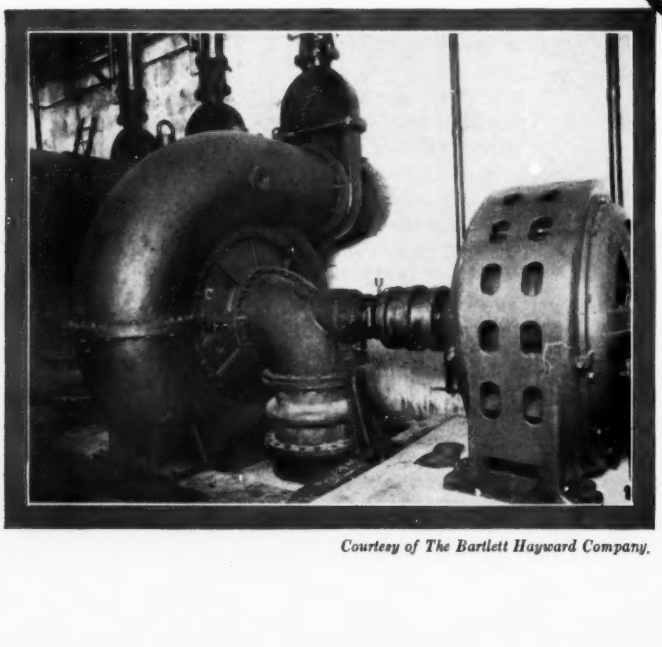
"A frequent cause of difficulty in the use of grease, by those inexperienced with ball bearings, is forcing an excessive amount of lubricant into the housing by means of a compres-



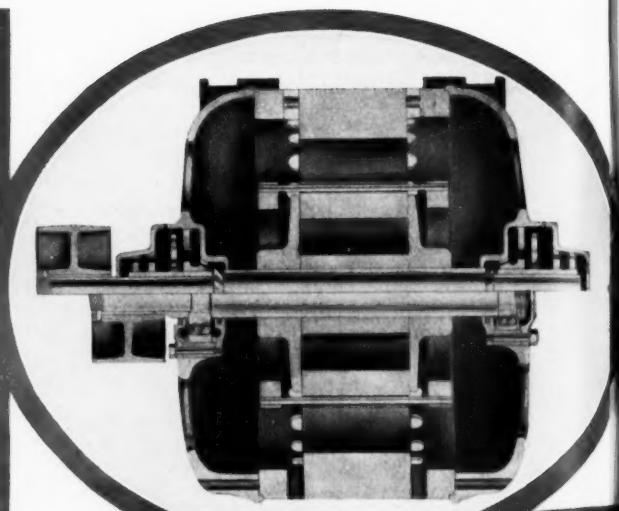
Courtesy of Fairbanks-Morse & Company.

Above.—A view of conditions under which an electric motor is often expected to operate.

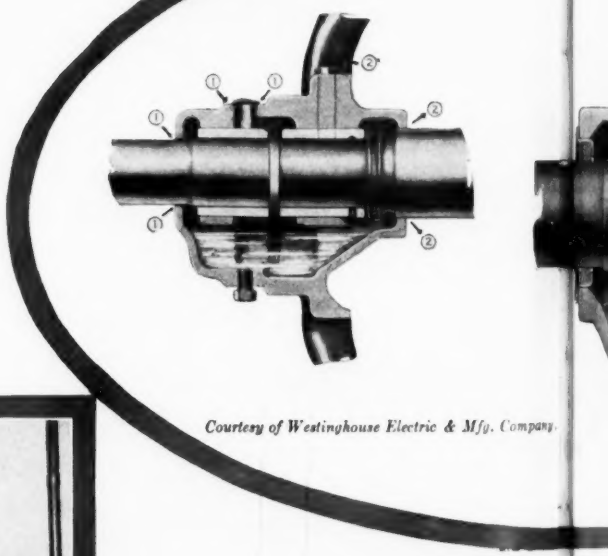
Below.—A motor driven centrifugal pump. A feature of this installation is the flexible coupling which effectively takes care of any possible misalignment, etc. Lubrication of this coupling is equally as important as lubrication of the bearings of the pump and motor.



Courtesy of The Bartlett Hayward Company.



Courtesy of S. K. F. Industries, Inc.

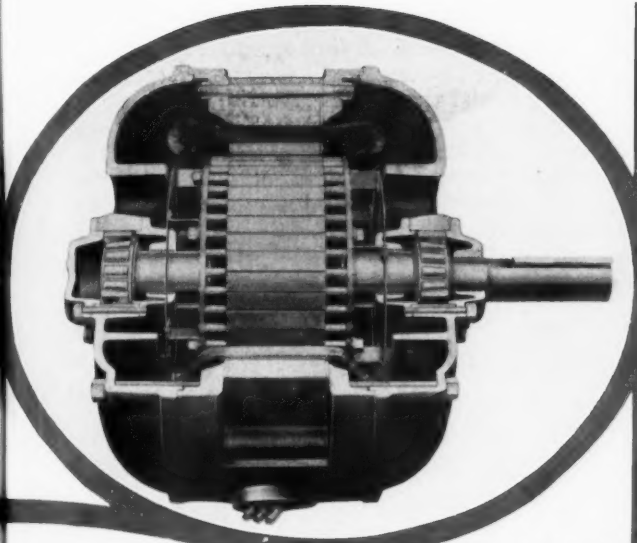


Courtesy of Westinghouse Electric & Mfg. Company.

Some Typical El
Details and In

Upper left oval.—Showing an electric motor with its shaft respectively equipped with ring oilers and ball bearings. Note the difference in space occupied.

Lower oval, to the left.—View of a typical sleeve bearing. Black arrows show the many openings that allow air, dust and grit to enter the bearing.

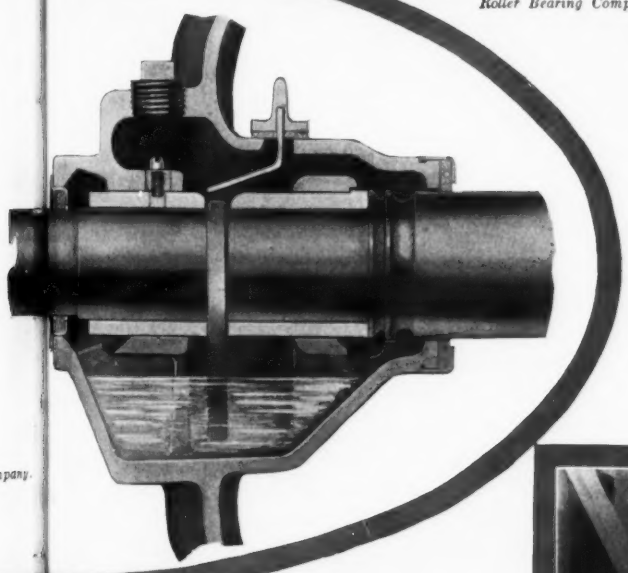


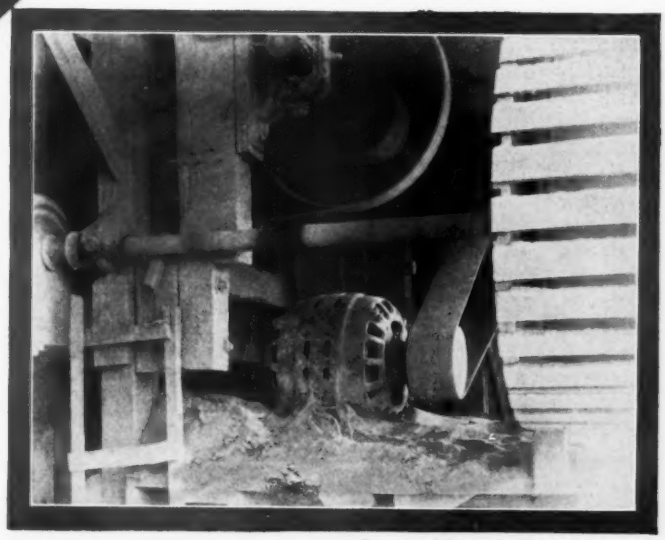
Courtesy of The Timken Roller Bearing Company.

Courtesy of Fairbanks-Morse & Company.

Above.—Where such conditions exist it can be appreciated that the most exacting requirements are imposed upon both motor and lubricant.

Below.—In view of the possibility of the presence of an excess of dust and dirt, the average electric motor must therefore be most carefully constructed and its lubricating system designed to function properly whatever the location or conditions involved.





Courtesy of Fairbanks-Morse & Company.

Electric Motor Installations

Upper right oval.—Cut away view of an Allis-Chalmers electric motor showing the manner in which tapered roller bearings can be applied to the rotor shaft. Effective sealing is a feature of this installation.

Lower oval, to the right.—A sealed-sleeve ring oiled bearing, the construction of which prevents the entry of air, dust, etc., and any possible escape of oil.

sion cup or other device. This leads to heating and often results in melting and breaking down of the grease, so that its lubricating value is destroyed. As a result further heating takes place and the operator attempts to remedy this by the addition of more grease, thus aggravating still further the cause of the trouble. In such cases the oily or lubricating constituent will leak out from the housing leaving the bearing entirely caked with the hard filler having no lubricating value whatever."

Courtesy of Fairbanks, Morse & Co.

Fig. 7—Section through one end of a ball-bearing type motor showing tightness of the housing, to prevent entry of dust, dirt, etc., or passage of lubricant to the motor windings.

In the opinion of W. B. Wachtler,* relative to flexible roller bearings—"Any system for introducing the lubricant into the bearing housing under pressure, such as with a grease gun or similar device, should be avoided, since it is impossible to determine when the right amount of lubricant has been forced into the housing. A further disadvantage is the fact that if oil or grease is introduced in excess of the capacity of the housing, the full pressure of the grease gun is available for forcing the lubricant out past the seals, and into the motor windings."

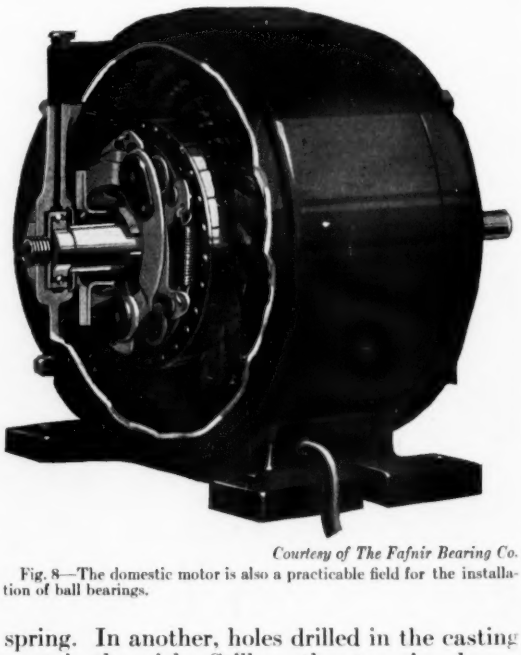
This advice would in general hold true for the average solid roller bearing installation as well. This would indicate that oil, in some respects, is a more desirable lubricant than grease. Another advantage of oil is that overlubrication can be more readily avoided due to the fact that oil will find its own level, which can be controlled by means of over-flow ports, a condition that can only be attained with the lighter grades of liquid greases. This is impossible with heavier products.

Greases for ball and roller bearing lubrication should be as free from acid forming tendencies as possible in order to insure adequate protection of the highly polished metallic surfaces. In effect this involves perfect neutrality, and of course the absence of fillers. The presence of any material that might give rise to oxidation and the development of free acidity, or to decomposition or settling is also prohibited. Properly compounded products will meet these requirements satisfactorily under normal conditions of operation, and there should be practically no tendency for them to cause corrosion or pitting of balls, rollers or raceways.

Whatever the lubricant specified, in general, a properly designed ball or roller bearing will require replenishment of this product but once every three or four months, or oftentimes at less frequent intervals if the housing is capable of holding a relatively large volume of lubricant, and an effective seal is maintained.

Wick Lubrication

Many fractional horsepower electric motor bearings are equipped with the wick system of lubrication, particularly where because of the portable nature of the motor application it is desirable, or where because of neglect or ignorance, lubrication will not be given frequent attention. Such applications are included in washing machines, portable vacuum cleaners, oil burners, house pumps, household refrigerating machines, etc. Among the so-called wick lubricating systems will be found the one involving an oil cup underneath the motor bearing containing a felt or candle wick which is pressed upward against the shaft with a spring. In another, holes drilled in the casting contain the wick. Still another type involves a



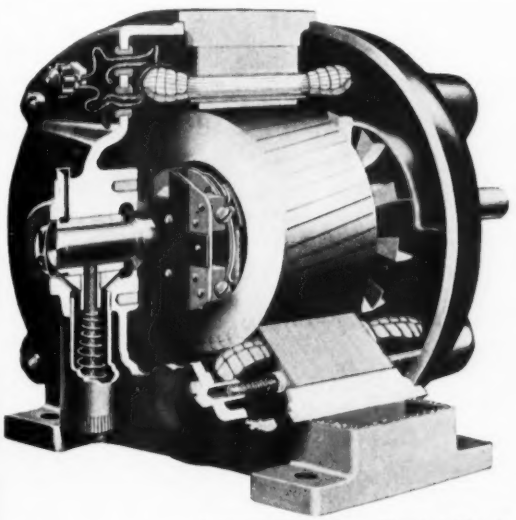
Courtesy of The Fafnir Bearing Co.

Fig. 8—The domestic motor is also a practicable field for the installation of ball bearings.

* Sales Mgr.—Industrial Division Hyatt Roller Bearing Co.

comparatively long felt wick placed at the side of the bearing attached to the shaft through a hole cut in the side of the bearing sleeve, the wick housing being open at top and bottom it being intended that the only oil in reserve will be that held in the felt by capillary attraction.

These might be termed "up-feed" types of lubrication, due to the fact that the flow of oil is upward through the pores of the wick of its



Courtesy of Westinghouse Electric & Mfg. Co.

Fig. 9—Details of a wick oiled electric motor. A combined wick guide and steady pin insures oil wick resting against the shaft. Oil which works out at end of the bearings is returned to the oil cups below, via suitable return passages.

own accord, the motion of the shaft or journal being required to draw the oil away from the uppermost portion of the wick with which it is in contact. These types of wick fed oilers are automatic in that the oiling stops and starts with the stopping and starting of the shaft or journal of the armature. Therefore, there is no chance of waste of oil during shut-down periods. Yet the wick is ready for immediate service as long as there is oil in the oil cup or the wick remains saturated.

In such bearings, as a rule, the viscosity of the oil used should be from 200 to 300 seconds Saybolt at 100° Fahr. Such oil should always have as low a cold test as possible to meet low temperature conditions wherever necessary, which is quite frequent when the motors are operating small pumps for house or farm supplies, garage air compressors, etc.

Waste Packed and Wool Yarn Systems of Lubrication

Other motors, in turn, particularly of the fractional horsepower variety are equipped with the so-called waste packed and wool yarn system of lubrication. Such systems consist generally of oil wells and bearing housings practically the same as supplied for the ring oiler system of lubrication, to provide an ample reservoir for the oil.

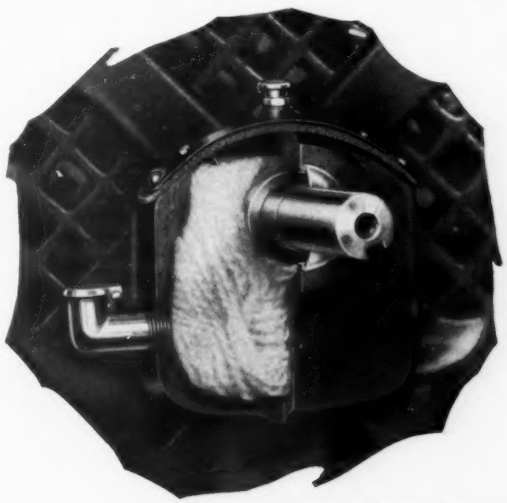
The effectiveness of the waste packed bearing depends upon careful packing of the bearing so that the pressure of the waste will insure its continued contact with the shaft or journal through one or more slots cut in the bearing sleeve. This may be on the top, sides or bottom of the latter.

In the wool yarn system of lubrication certain advantages brought out by Century Electric Company for fractional horsepower motors are of decided interest, viz:

"1. The strands of wool yarn lay across the shaft in a slot in the bearing sleeve such as is usually provided for a ring oiler, the long ends of the yarn being packed down into the oil well.

2. The strands of wool yarn being continuous and unbroken, permit capillary action to assert itself completely. Under heavy bearing pressures this system has shown itself in thousands of cases in regular service applications, to be the equal of any lubrication method in keeping down bearing wear and temperature in fractional horsepower motors.

3. Because of capillary activity and the filtering properties of pure wool yarn, all oil is completely filtered through the yarn fibre before delivery to the bearing surface.



Courtesy of Century Electric Co.

Fig. 10—A wool yarn lubricated motor bearing showing bearing construction, details of packing, oil plug and overflow gage.

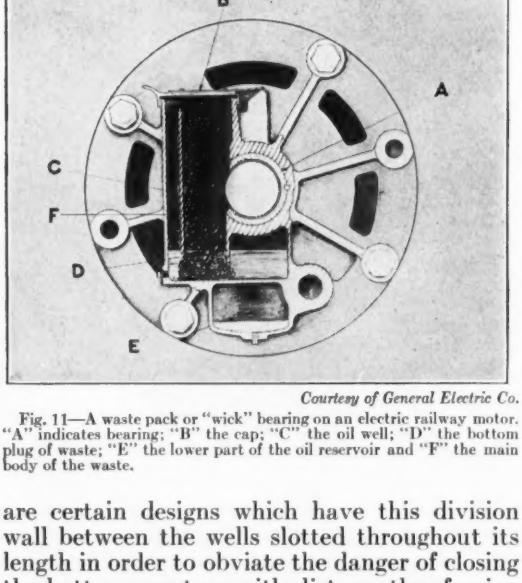
4. Wool yarn lubrication eliminates all tendency of oil bubbling—no possibility of clogging up the oil returns to the oil well.

5. The use of the wool yarn system of lubrication eliminates the danger from leaks from an oil well, since the wool yarn itself will hold in suspension sufficient oil to properly lubricate a fractional h. p. motor for at least one year's continuous 24-hour-per-day operation.
6. It increases the total capacity of the small motor ring oiler type of oil well about 100%, due to the additional oil held in suspense in the yarn.
7. Positive lubrication under all conditions even at extremely low room temperature.
8. Long-time service without re-oiling is assured by the above factors."

Such bearings, as a rule, will also require an oil of from 200 to 300 sec. Saybolt viscosity at 100° Fahr. The oil should always have as low a cold test as possible to meet low temperature conditions wherever necessary, which may be quite frequent.

Electric Railway Motors

A word in regard to the electric railway motor and its lubrication will also be of interest in connection with this discussion of waste and wool yarn lubrication. With the modern type of motor used for such service the more usual principles of design are shown in Fig. 12. It will be noted that a waste well is provided into which the bearing window or aperture looks. Adjacent to the waste well is an oil well. The two wells are connected by a hole at the bottom of the partition wall. On the other hand there



Courtesy of General Electric Co.

Fig. 11—A waste pack or "wick" bearing on an electric railway motor. "A" indicates bearing; "B" the cap; "C" the oil well; "D" the bottom plug of waste; "E" the lower part of the oil reservoir and "F" the main body of the waste.

are certain designs which have this division wall between the wells slotted throughout its length in order to obviate the danger of closing the bottom aperture with dirt or other foreign matter. In this system of lubrication the capillarity of the waste is used to raise the oil from the bottom of the housing to the bearing. The purpose is to give a more uniform oil feed and to exclude dirt. After such a bearing has been properly packed with well saturated waste, oil is added to the oil well to a level of approxi-

Courtesy of Electric Railway Journal.

Fig. 12—Another view of an electric railway motor showing details of housing, and how the wick should be packed.

mately ¾" from the bearing window; it should never be allowed to feed to a point lower than 3" below the window or within a half inch of the bottom.

When more oil is added than is indicated by the high level, the feed is too fast to be economical and it may even cause damage through short circuits by oil being thrown on to the commutator. To permit the level to drop below the minimum named, reduces in turn the rate of feed below that required for good lubrication. In this connection it should be remembered that the higher the lift required of the waste, the less oil will be delivered to the bearings.

Research has developed that the rate of oil feed is largely controlled by the viscosity of the oil, the higher the viscosity of the latter, the lower the rate. The importance of changing to seasonal grades of oil at the proper time is therefore imperative, inasmuch as the viscosity increases accordingly as the temperature is lowered.

The correct way of packing the modern type of electric railway motor consists of drawing the wool waste into a skein long enough to reach the bottom of the waste well and to extend over

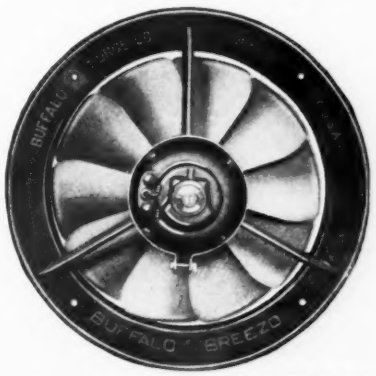
the bearing window. This skein should be also long enough to enable the oiler to hold it in place while packing the remainder of the waste. The former acts as the wick and should be large enough to completely fill the window. After the wick skein is in place, waste is worked down behind it with a packing iron to wedge the wick up and hold it in position against the armature shaft. A small piece of dry waste should be added on top to act as a dust plug. A properly packed waste well will hold more waste than one in which the latter is merely shoved in in balls. The additional waste improves the feed and insures the necessary oil flow when the proper levels are maintained. When oiling in the car barn, it becomes necessary on some types of cars for the oiler to pack motors by feeling rather than sight, due to the fact that the bearing is located under and close to the car floor rather than under the floor traps. In such cases more than the usual care must be taken to prevent the waste from touching dirty parts of the cars under the floor.

All modern type motors should be gauged for oil level in the oil wells and only the amount of oil necessary to bring the level to the proper height should be added. Should gauging show that very little oil has been fed since the last inspection, there is good reason to believe that the hole at the bottom between the two wells is plugged and it should be cleaned before oil is added. If the hole is kept open, all oil should be added through the oil well rather than to the top of the waste. Some dust is bound to get into the waste, and adding the oil on top washes the dust down to the bearing. If evidence of water is found in the waste, the waste should be removed and the bearing packed with new waste as the water tends to emulsify with the impurities present, thus glazing the waste at the shaft, shutting off the oil feed. Motors subjected to high electrical heat should also be inspected frequently for glazed waste.

Flushing and Cleaning of Bearings

In order to insure the maximum of protection from any motor bearing lubricant it is absolutely essential to keep the lubricating system as free from foreign matter as is consistently possible, according to the operating conditions and bearing construction. Mention has already been made of the possibility of entrance of impurities, especially where the bearing is not properly sealed. It is a matter of decided importance for we can realize that continued churning of abrasive foreign matter with oil or grease, and its passage through plain bearing clearance spaces or in intimate contact with highly polished balls, rollers and raceways, will ultimately prove the ruination of the shaft, bearing and its respective elements, whether these may be rings, rollers, balls, or wool waste.

In view of the fact that it is not always possible to effect the requisite degree of sealing



Courtesy of Buffalo Forge Co.

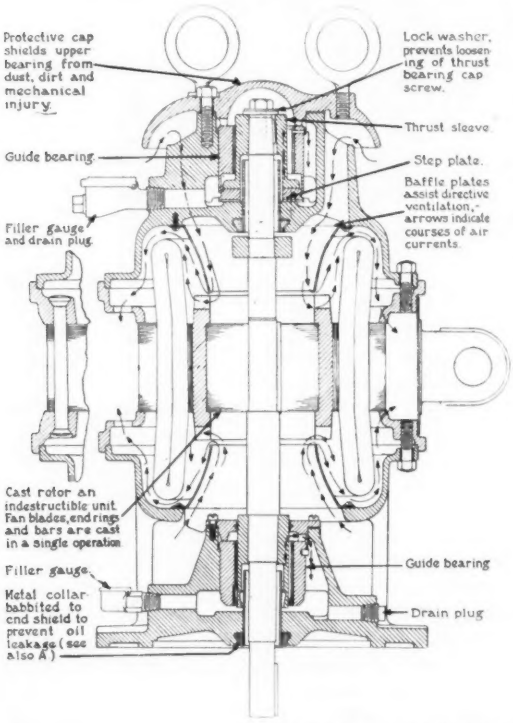
Fig. 13—End view of a motor driven fan with bearings equipped for waste-pack lubrication.

or to depend upon the seal being in good working order at all times, motor bearing lubricating systems should be flushed and cleaned at periodic intervals. The frequency will, of course, depend upon the design of the bearing, the type of seal, the lubricant used and the extent to which dust and dirt are present. Ring oiling systems will in general require more frequent attention than ball or roller bearings, due to the fact that their housings are often less carefully designed. With the former cleaning may be necessary or advisable at periods ranging from every two weeks to every several months. With ball or roller bearings, once or twice a year is sufficient, unless operating conditions are especially dirty. On the other hand, the latter are more delicate from the viewpoint of construction, and therefore oil or grease should not be allowed to become as contaminated as is permissible with other types of bearings. Wherever grease lubricated ball or roller bearings are involved, the grease should be wiped out thoroughly at the period of cleaning; flushing is generally not an entirely satisfactory procedure.

Ring oiling systems also possess natural advantages in that the flood of oil which is constantly passing through the bearings tends to wash out any grit, dirt, dust, or metallic particles that may have gained entry. As a result, wear is reduced to a minimum, just as long as the oil in the system does not become so highly contaminated as to be unable to precipitate such foreign matter during its period of so-called rest. This flooding of bearings, by virtue of its washing action, naturally gives rise to gradual accumulation of foreign matter, therefore the condition of the oil should be carefully

watched, and the system drained immediately any excess of dirt becomes apparent.

The instructions for flushing a bearing housing and lubricating system as stated by W. B. Wachtler* for Hyatt Roller Bearings are so complete that they are stated in full below. While prepared specifically for users of this type of bearing, the general principles involved with the exception perhaps of the matter of


Protective cap shields upper bearing from dust, dirt and mechanical injury
Lock washer, prevents loosening of thrust bearing cap screw.
Thrust sleeve
Guide bearing
Step plate.
Baffle plates assist directive ventilation,- arrows indicate courses of air currents.
Filler gauge and drain plug
Cast rotor an indestructible unit. Fan blades, end rings and bars are cast in a single operation
Guide bearing
Filler gauge
Metal collar babbitted to end shield to prevent oil leakage (see also A)
Drain plug

Courtesy of General Electric Co.

Fig. 14—A vertical type of electric motor showing construction of step and guide bearings, and provisions for lubrication.

frequency can well be applied to practically any type of oil lubricated electric motor bearing, viz.:

"It is advisable about once a year to clean out of the housing any accumulated grit or particles of metal, and to dissolve any gummed oil, since the effect of this foreign matter upon the rate of wear of the bearing is cumulative. The simplest way in which the housing can be cleaned out is to remove the top and bottom plug from the housing, and drain out the lubricant. Then replace the bottom plug and pour kerosene or gasoline or a light lubricating oil heated to about 200 deg. F. into the top hole until it appears at the oil filler hole level. All plugs should then be replaced and the motor turned over slowly by hand a few times to distribute the solvent. After about 10 minutes the kerosene can be drained out and the motor turned over slowly by hand with all of the plugs removed, so that most of the solvent is removed. The bottom plug should then be replaced, and about a half pint of clean oil poured into the housing and the motor given a few turns to distribute it. This oil will remove most of the kerosene which might otherwise have a harmful effect on the lubricating qualities of the new supply of oil. When this small quantity of oil has been removed, and the bottom plug replaced, the housing is ready to be filled up to the proper oil level, and operation resumed."

CONCLUSION

In view of the variety of lubricating systems involved it can be appreciated that electric motor lubrication is worthy of our utmost consideration. Simply because it is possible to stick a motor in the most unfavorable locality and practically forget it for perhaps a week or a month is no indication that when it does require re-lubrication, this can be carried out in a slipshod manner with inferior lubricants. To meet operating requirements and attain continued efficient service, every electric motor, whatever its duty, must be understood from the viewpoint of its lubricating system, and served with lubricants suited not only to the latter but also to the operating conditions. To enable such an understanding has, therefore, been the object of this article.

* Sales Mgr.—Industrial Division, Hyatt Roller Bearing Co. In a paper which appeared in the *Iron & Steel Engineer*, May, 1924.

Printed in U. S. A. by
EDGAR C. RUWE CO., INC.
47 West Street, N. Y. C.